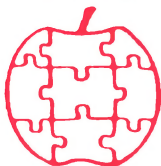


# Apple

\$1.80



# Assembly

# Line

Volume 7 -- Issue 7

April, 1987

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## Bytestalker Software Analyzer Card

Old-fashioned computers always came with a front panel, loaded with lights and switches. You could usually stop a program, single-step it, and even set a breakpoint address to halt execution at a particular address. Personal computers don't include front panels, but now you can add part of one to your Apple. J. Stuart Enterprises, Box 310, Grass Valley, CA 95945, is offering the Bytestalker Software Analyzer Card. The card includes 16 switches for selecting a breakpoint address, a three-position mode switch (run, stop, trap), and a two position step-hold switch. There are also six single hex digit displays, to show you address and contents. You can choose single-stepping at the machine cycle level, or the instruction level. The price is only \$88.50, plus postage and insurance. Contact J. Stuart at the above address or at phone (916) 273-9188.

## We're Gaining on it...

We've gained about a week in our efforts to get AAL back on schedule: it looks like the April issue will actually get to the printer during April! Next month we'll be shooting to get the May issue in the mail before the end of May, and soon you'll be receiving each month's issue during the appropriate month. Thanks for your patience.

In the very first issue of AAL, back in October 1980, I wrote an article about an interpretive screen display subroutine. A lot of things have happened since 1980! Although perhaps it is insignificant compared to the rise and fall of nations, one change which dramatically affects Apple programmers is that now almost everything is done on an 80-column screen. That old message printer was tied to the 40-column screen, so I think an upgrade is in order.

The following program has more features than the 1980 version, and is also easier to use. Another nice change since 1980 is that most of the assemblers available for the Apple now include a macro capability. Macros make it easier to use special coded sequences of bytes like those necessary in the message printer.

Where is the message?

There are many different ways to tell a message-printing subroutine where the message to be printed is located in memory. The method I used in my 1980 article was to assign a message number to each message, and pass that number in the A-register; the message printer used the message number as an index to a table of message addresses. Sometimes I have used the message number technique without a table of message addresses: I put all the messages together in one consecutive area of memory; the message printer searched through the messages counting end-of-message characters until it found the N-th message, and then started printing.

I show two other techniques in the program which follows. The first one involves loading the full address of the message to be printed into the A- and Y-registers. In my program I put the high-byte of the address in the Y-register, and the low-byte in the A-register. Of course you could use any registers any way you wish, but this is what I used. The code for MESSAGE.PRINTER is shown in lines 1250-1380. I defined a macro named "MSG" in lines 1190-1230 to make it easier to write the code to call the message printer. Calls to the message printer may be written simply as one-line macro calls, such as:

```
>MSG TITLE
>MSG COPYRIGHT
```

where TITLE and COPYRIGHT are the names of specific messages assembled elsewhere in a program.

The other technique I show here is probably the most popular one, if the programs I have disassembled are any indication. In this method the text of the message to be printed immediately follows the JSR to the message printer. The message printer uses the return address placed on the stack by the JSR to locate the message. After the message is printed, the return address is modified so that it points to the next instruction after the message before RTSing. ANOTHER.MESSAGE.PRINTER is shown in lines 1420-1640.

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Both message printers begin by storing the address of the message into a page-zero pointer. Then a subroutine named GET.NEXT.CHAR in lines 1680-1750 is called to pick up characters of the message. Since the last instruction in this subroutine is the one which picks up the character, the Zero-status will be set if the \$00 byte indicating end-of-message is picked up.

What is in the Message?

The real intelligence of my message printers is in the subroutine PUT.CHAR, starting at line 1760. We have already mentioned that a \$00 byte indicates end-of-message. PUT.CHAR expects the X-register to contain a repeat count, and the A-register to contain the character to be printed. If the byte in the A-register has a value between \$40 and \$FF, it is sent to COUT to be printed (X) times. However, if the byte in the A-register has a value between \$01 and \$3F, it is interpreted in special way.

Values between \$80 and \$9F are control characters, and will be interpreted by the monitor firmware. If you are in an 80-column //e, //c, or //gs, the interpretation will be as shown in lines 1850-2070. In 40-column mode not all of the functions are active. A Viewmaster or other type of 80-column card will have its own set of controls.

Values between \$01 and \$18 are interpreted by PUT.CHAR as the first byte of a two-byte cursor position code. This first byte indicates the line number (1-24 decimal) to put the cursor on, and the following byte is the column number (0-79 decimal). I defined a macro "POS" in lines 2100-2130 to simplify putting position codes into messages.

Values between \$19 and \$3F are used to index a special function table. My table is shown in lines 2700-2840. Notice that I used a macro "FUN" to write each entry in the table. This macro defines the special function code as "F.name", and assembles the address-1 of the code which performs the function. I thought of seven handy functions, but you can probably think of a lot more. As you do, just add >FUN lines to the table and write subroutines to perform the functions. Use mine as models, and you should be successful.

The methods I used for setting up the cursor position and handling other special functions work with Apple's firmware in the 40- and 80-column modes; if you have a Viewmaster or other 80-column card, you will need to make some changes in PUT.CHAR and its subroutines.

I made macros for the all of the functions, shown in lines 2140-2460. You might also find it handy to define macros for some of the control-characters processed by the 80-column firmware, but I didn't do it here.

Even though I have the "POS" function for positioning the cursor on the screen, I still wanted the ability to do HTAB and VTAB independently. These are my first two functions. By

writing ">HTAB xx" you can position to column xx on the current line. ">VTAB yy" will put the cursor on line yy without changing the column. Again, yy is a number between 1 and 24, and xx runs from 0 to 79 (decimal).

If you remember, normal characters are printed N times according to the value in the X-register when you call PUT.CHAR. The REP function lets you set up the repeat count. ">REP n,char" will cause char to be printed n times.

The CEN function is perhaps the most powerful one. It centers a string on the current line. You simply write something like

```
>CEN "This string will be centered"
```

...and it will be. The code for this function is in lines 3020-3180. All characters which follow the CEN function code are counted, up to the next function code or control character. Then the position for the first character is computed by halving the difference between window width and string length, and an HTAB performed.

FIL and FCL will fill an entire line with a specified character. FIL lets you say which line, and FCL fills the current line. You could do the same thing by putting the cursor at the beginning of the line to be filled and then using a repeat count larger than the window width followed by the fill character, but this way is easier. Let the computer work for you!

WIN lets you specify a window on the screen. This is very rudimentary as window routines go, because all it does is load the four locations the monitor uses to define the window: left, width, top, and bottom. "Left" is the column number to start the window at, and is a value from 0 to 79. "Width" is the number of characters in a line, and has a value from 1 to 80. Just be sure that these two numbers do not add to a value greater than 80, unless you really want to clobber your program. "Top" is the line number of the top of the window, having a value from 0 to 23. "Bottom" is the line number of the bottom line of the window, plus 1; the value goes from 1 to 24. The full 80-column window would be set up with ">WIN 0,80,0,24".

How about some examples?

I wrote two sample programs. "T", in lines 3500-3540, calls MESSAGE.PRINTER to print the messages in lines 3560-3790. "TT", in lines 3950-4170, calls ANOTHER.MESSAGE.PRINTER to print embedded messages.

```

20-      1010 *SAVE S-C.MSG.MACHINE
21-      1020 *-----
22-      1030 MON.LEFT   .EQ $20
23-      1040 MON.WIDTH  .EQ $21
24-      1050 MON.TOP    .EQ $22
25-      1060 MON.BOTTOM .EQ $23
      1070 MON.CH       .EQ $24
      1080 MON.CV       .EQ $25
      1090 *-----
057B-    1100 MON.CH80   .EQ $57B
      1110 *-----
```

# DOS Anatomy

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  - 2) One disk drive (using 5-1/4 inch diskettes).
  - 3) DOS 3.3 operating system. (Note: In order to conserve disk space, all files are housed on DOS-less data disks. Therefore, you must boot with a normal version of DOS 3.3 before this software package can be used.)
  - 4) Printer that can support a 132-character line length in condensed or normal modes. (A smaller printer width can be used but is not recommended.)
- Optional---
- 5) MERLIN (a.k.a. "BIG MAC") assembler. (An assembler is not required if you just wish to review the text file contents. Text files containing numerical and alphabetical cross-referenced symbol tables are provided to assist programmers who own a different brand of assembler.)
  - 6) The book "BENEATH APPLE DOS" would prove helpful.

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```

FC22-      1120 MON.VTAB      .EQ $FC22
FDED-      1130 MON.COUT     .EQ $FDED
          1140 *-----
00-        1150 MSG.PNTR     .EQ $00,01
          1160 *-----
          1170 *   Address of message in Y,A registers
          1180 *-----
          1190      .MA MSG      >MSG <message address>
          1200      LDA #11
          1210      LDY /11
          1220      JSR MESSAGE.PRINTER
          1230      .EM
          1240 *-----
          1250 MESSAGE.PRINTER
0800- 85 00 1260      STA MSG.PNTR      Store message address
0802- 84 01 1270      STY MSG.PNTR+1    into page-zero pointer
0804- 8A      1280      TXA              Save X-register
0805- 48      1290      PHA
0806- A2 01 1300      LDY #1          Clear repetition counter
0808- 20 3F 08 1310      JSR GET.CHAR    First char of message
080B- F0 08 1320      BEQ .2          ...empty message!
080D- 20 44 08 1330      .1 JSR PUT.CHAR    Process the character
0810- 20 39 08 1340      JSR GET.NEXT.CHAR get another one
0813- D0 F8 1350      BNE .1          ...not at end of message yet
0815- 68      1360      PLA          Restore X-register
0816- AA      1370      TAX
0817- 60      1380      RTS              Return to caller
          1390 *-----
          1400 *   Message follows JSR to message printer
          1410 *-----
          1420 ANOTHER.MESSAGE.PRINTER
0818- 68      1430      PLA              Store message address (-1)
0819- 85 00 1440      STA MSG.PNTR      into page-zero pointer
081B- 68      1450      PLA
081C- 85 01 1460      STA MSG.PNTR+1
081E- 8A      1470      TXA              Save X-register
081F- 48      1480      PHA
0820- 98      1490      TYA              Save Y-register
0821- 48      1500      PHA
0822- A2 01 1510      LDY #1          Clear repetition counter
0824- D0 03 1520      BNE .2          ...Always
0826- 20 44 08 1530      .1 JSR PUT.CHAR    Process a character
0829- 20 39 08 1540      .2 JSR GET.NEXT.CHAR
082C- D0 F8 1550      BNE .1          ...not at end of message yet
082E- 68      1560      PLA              Restore Y-register
082F- A8      1570      TAY
0830- 68      1580      PLA              Restore X-register
0831- AA      1590      TAX
0832- A5 01 1600      LDA MSG.PNTR+1    Get return address back on stack
0834- 48      1610      PHA
0835- A5 00 1620      LDA MSG.PNTR
0837- 48      1630      PHA
0838- 60      1640      RTS              Return to caller
          1650 *-----
          1660 *   Get a message character
          1670 *-----
          1680 GET.NEXT.CHAR
0839- E6 00 1690      INC MSG.PNTR
083B- D0 02 1700      BNE GET.CHAR
083D- E6 01 1710      INC MSG.PNTR+1
          1720 GET.CHAR
083F- A0 00 1730      LDY #0
0841- B1 00 1740      LDA (MSG.PNTR),Y
0843- 60      1750      RTS
          1760 *-----
          1770 *   Process a message character
          1780 *
          1790 *   $00      END OF MESSAGE
          1800 *   $YY XX  where Y is between $01 and $18, position
          1810 *           the cursor as vtab YY, htab XX.
          1820 *   $19-3F  special functions
          1830 *   $40-FF  print as is
          1840 *
          1850 *   Characters between $80 and $9F are interpreted by
          1860 *   the Apple 80-column firmware as follows:
          1870 *
          1880 *   $87      bell
          1890 *   $88      backspace
          1900 *   $8A      move cursor down one line

```

```

1910 *      $8B      clear from cursor to end of window
1920 *      $8C      clear window and home cursor
1930 *      $8D      carriage return
1940 *      $8E      normal video
1950 *      $8F      inverse video
1960 *      $91      switch to 40-column
1970 *      $92      switch to 80-column
1980 *      $95      de-activate firmware
1990 *      $96      scroll display down one line
2000 *      $97      scroll display up one line
2010 *      $98      disable Mouse Text
2020 *      $99      home cursor without clearing window
2030 *      $9A      clear current line
2040 *      $9B      enable Mouse Text
2050 *      $9C      move cursor forward one space
2060 *      $9D      clear to end of line
2070 *      $9F      move cursor up one line
2080 *-----
2090 *      Message Content Macros
2100 *-----
2110      .MA POS      Position cursor (vtab, htab)
2120      .DA #]1,#]2
2130      .EM
2140 *-----
2150      .MA REP      Repeat character N times
2160      .DA #F.REP,#]1,#"]2
2170      .EM
2180 *-----
2190      .MA CEN      Center a string on current line
2200      .DA #F.CEN
2210      .AS -"]1"
2220      .EM
2230 *-----
2240      .MA STR      normal Ascii string
2250      .AS -"]1"
2260      .EM
2270 *-----
2280      .MA FIL      Fill specified line with character
2290      .DA #F.FIL,#]1,#"]2
2300      .EM
2310 *-----
2320      .MA FCL      Fill current line with character
2330      .DA #F.FCL,#"]1
2340      .EM
2350 *-----
2360      .MA WIN      Define a new text window
2370      .DA #F.WIN,#]1,#]2,#]3,#]4
2380      .EM
2390 *-----
2400      .MA HTAB     Htab the cursor
2410      .DA #F.HTAB,#]1
2420      .EM
2430 *-----
2440      .MA VTAB     Vtab the cursor
2450      .DA #F.VTAB,#]1
2460      .EM
2470 *-----
2480 PUT.CHAR
2490      CMP #$40      IS IT PRINTABLE?
2500      BCC .2        ...NO, SPECIAL FUNCTION
2510      JSR MON.COUT
2520      DEX            Decrement repeat count
2530      BNE .1        ...repeat the character
2540      INX            Put the repeat count back to 1
2550      RTS
2560 *---Process function char-----
2570      .2      CMP #$19      >POS VV,HH or special function?
2580      BCC P.POS      ...>POS call
2590 *---Branch to function code-----
2600      ASL            Double function # to make index
2610      TAY
2620      CPY #FUN.TBL.SZ
2630      BCS .3        ...Ignore illegal function
2640      LDA FUN.TBL+1,Y
2650      PHA            Put function code address-1 on stack
2660      LDA FUN.TBL,Y
2670      PHA
2680      .3      RTS            Go to it!
2690 *-----
0844- C9 40      2490      CMP #$40      IS IT PRINTABLE?
0846- 90 08      2500      BCC .2        ...NO, SPECIAL FUNCTION
0848- 20 ED FD   2510      JSR MON.COUT
084B- CA        2520      DEX            Decrement repeat count
084C- D0 FA      2530      BNE .1        ...repeat the character
084E- E8        2540      INX            Put the repeat count back to 1
084F- 60        2550      RTS
2560 *---Process function char-----
0850- C9 19      2570      .2      CMP #$19      >POS VV,HH or special function?
0852- 90 1F      2580      BCC P.POS      ...>POS call
2590 *---Branch to function code-----
0854- 0A        2600      ASL            Double function # to make index
0855- A8        2610      TAY
0856- C0 42      2620      CPY #FUN.TBL.SZ
0858- B0 08      2630      BCS .3        ...Ignore illegal function
085A- B9 32 08   2640      LDA FUN.TBL+1,Y
085D- 48        2650      PHA            Put function code address-1 on stack
085E- B9 31 08   2660      LDA FUN.TBL,Y
0861- 48        2670      PHA
0862- 60        2680      .3      RTS            Go to it!
2690 *-----

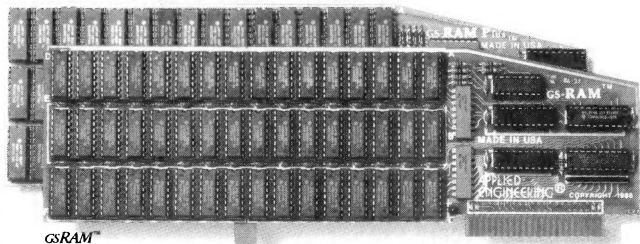
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```

2700      .MA FUN
2710 F.]1 .EQ *-FUN.TBL/2
2720      .DA P.]1-1
2730      .EM
2740      *-----
0831- 2750 FUN.TBL.EQ *-$19-$19
0863- 2760 >FUN VTAB      Vtab YY
0865- 2770 >FUN HTAB      Htab XX
0867- 2780 >FUN REP      Repeat, count, character
0869- 2790 >FUN CEN      Center, string, null
086B- 2800 >FUN NUL      ...ends centered string
086D- 2810 >FUN FIL      Fill, line #, char
086F- 2820 >FUN FCL      Fill current line, char
0871- 2830 >FUN WIN      Window, left, width, top, bottom
42- 2840 FUN.TBL.SZ .EQ *-FUN.TBL
2850      *-----
0873- 20 BC 08 2860 P.POS JSR MY.VTAB      Do vertical tab
0876- 20 39 08 2870 P.HTAB JSR GET.NEXT.CHAR    ...get horoz value
0879- C5 21 2880 CMP MON.WIDTH      Stay inside current window
087B- 90 04 2890 BCC .1          ...it is inside
087D- A5 21 2900 LDA MON.WIDTH      ...use right edge
087F- E9 01 2910 SBC #1
0881- 85 24 2920 .1 STA MON.CH      40-column horiz pos'n
0883- 8D 7B 05 2930 STA MON.CH80      80-column horiz pos'n
0886- 60 2940 RTS
2950      *-----
0887- 20 39 08 2960 P.REP JSR GET.NEXT.CHAR
088A- AA 2970 TAX      REPETITION COUNT
088B- 60 2980 RTS
2990      *-----
3000      * Center a string on current line
3010      *-----
088C- A0 00 3020 P.CEN LDY #0      Count # chars in string
088E- C8 3030 .1 INY      from next char to char below $40
088F- B1 00 3040 LDA (MSG.PNTR),Y    or btwn $80 and $9F
0891- 30 04 3050 BMI .2      80-FF
0893- C9 40 3060 CMP #$40
0895- B0 F7 3070 BCS .1      40-7F, keep counting
0897- C9 A0 3080 .2 CMP #$A0
0899- B0 F3 3090 BCS .1      A0-FF, keep counting
089B- 88 3100 DEY      00-3F or 80-9F, end of string
089C- 98 3110 TYA      (Line.width - string.len) / 2
089D- 49 FF 3120 EOR #$FF      gives starting horiz posn
089F- 38 3130 SEC
08A0- 65 21 3140 ADC MON.WIDTH
08A2- 4A 3150 LSR
08A3- 85 24 3160 STA MON.CH
08A5- 8D 7B 05 3170 STA MON.CH80
08A8- 60 3180 P.NUL RTS
3190      *-----
08A9- 20 39 08 3200 P.FIL JSR GET.NEXT.CHAR
08AC- 20 BC 08 3210 JSR MY.VTAB
3220 P.FCL
08AF- A9 00 3230 LDA #0
08B1- 85 24 3240 STA MON.CH
08B3- 8D 7B 05 3250 STA MON.CH80
08B6- A6 21 3260 LDX MON.WIDTH
08B8- 60 3270 RTS
3280      *-----
08B9- 20 39 08 3290 P.VTAB JSR GET.NEXT.CHAR
3300 MY.VTAB
08BC- C5 23 3310 CMP MON.BOTTOM      Stay inside current window
08BE- 90 02 3320 BCC .1          ...it is inside
08C0- A5 23 3330 LDA MON.BOTTOM      Go to bottom line
08C2- 85 25 3340 .1 STA MON.CV      We use line # 1 to N, but
08C4- C6 25 3350 DEC MON.CV      monitor uses 0 to N-1
08C6- 4C 22 FC 3360 JMP MON.VTAB
3370      *-----
08C9- 20 39 08 3380 P.WIN
08CC- 85 20 3390 JSR GET.NEXT.CHAR
08CE- 20 39 08 3400 STA MON.LEFT
08D1- 85 21 3410 JSR GET.NEXT.CHAR
08D3- 20 39 08 3420 STA MON.WIDTH
08D6- 85 22 3430 JSR GET.NEXT.CHAR
08D8- 20 39 08 3440 STA MON.TOP
08DB- 85 23 3450 JSR GET.NEXT.CHAR
08DD- A9 99 3460 STA MON.BOTTOM
08DF- 4C ED FD 3470 LDA #$99
3480 JMP MON.COUT

```

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```

3490 #-----
08E2- 3500 T      >MSG MSG0
08E9- 3510      >MSG MSG2
08F0- 3520      >MSG MSG1
08F7- 3530      >MSG MSG3
08FE- 60 3540      RTS
3550 #-----
08FF- 8C 3560 MSG0 .HS 8C      HOME SCREEN
0900- 3570      >WIN 10,38,0,24
0905- 3580      >FIL 1,-      FILL TOP LINE WITH DASHES
0908- FC 3590      .HS FC      ONE BAR ON NEXT LINE
0909- 8D 88 FC
090C- FC 3600      .HS 8D.88.FC.FC  2 BARS
090D- 8D 88 FC
0910- FC 3610      .HS 8D.88.FC.FC  2 BARS
0911- 8D 88 FC
0914- FC 3620      .HS 8D.88.FC.FC  2 BARS
0915- 8D 88 FC
0918- FC 3630      .HS 8D.88.FC.FC  2 BARS
0919- 8D 88 FC
091C- FC 3640      .HS 8D.88.FC.FC  2 BARS
091D- 8D 88 FC
0920- FC 3650      .HS 8D.88.FC.FC  2 BARS
0921- 8D 88 FC 3660      .HS 8D.88.FC      1 BAR AT END OF LINE
0924- 3670      >FCL -      FULL CURRENT LINE WITH DASHES
0926- 3680      >POS 3,0      VTAB 3, HTAB 0
0928- 8F 3690      .HS 8F      INVERSE MODE
0929- 3700      >CEN "Demonstration of Message Printer"
094A- 8E 8D 8D 3710      .HS 8E.8D.8D      Normal mode
094D- 3720      >CEN "S-C Software Corporation"
0966- 8D 3730      .HS 8D
0967- 3740      >CEN "P. O. Box 280300"
0978- 8D 3750      .HS 8D
0979- 3760      >CEN "Dallas, TX 75228"
098A- 8D 8D 8D 3770      .HS 8D.8D.8D
098D- 3780      >WIN 0,80,0,24      Full screen again
0992- 00 3790      .HS 00      End of message
3800 #-----
0993- 3810 MSG1 >POS 11,1      VTAB 11, HTAB 1
0995- 9D 3820      .HS 9D      CLR EOL
0996- 3830      >STR "SELECT ONE: "
09A3- 00 3840      .HS 00      End of message
3850 #-----
09A4- 3860 MSG2 >POS 24,1      VTAB 24, HTAB 1
09A6- 8F 3870      .HS 8F      INVERSE MODE
09A7- 3880      >STR " <SPACE> FOR MENU, <RETURN> FOR MORE "
09CC- 8E 00 3890      .HS 8E.00      NORMAL MODE, EOM
3900 #-----
09CE- 87 87 8D 3910 MSG3 .HS 87.87.8D
09D1- 3920      >STR "Wasn't that a nice demonstration?"
09F2- 8D 00 3930      .HS 8D.00
3940 #-----
09F4- 20 18 08 3950 TT JSR ANOTHER.MESSAGE.PRINTER
09F7- 8D 8D 3960      .HS 8D.8D
09F9- 3970      >CEN "This is another way to print messages."
0A20- 3980      >HTAB 0
0A22- 3990      >STR "<<<"
0A25- 4000      >HTAB 99      TAB TO END OF LINE
0A27- 88 88 4010      .HS 88.88      BACK UP TWO SPACES
0A29- 4020      >STR ">>>"
0A2C- 8D 00 4030      .HS 8D.00
0A2E- 20 18 08 4040 JSR ANOTHER.MESSAGE.PRINTER
0A31- 4050      >REP 10,M-$40      10 CARRIAGE RETURNS
0A34- 4060      >WIN 0,1,14,24
0A39- 4070      >REP 10,1
0A3C- 4080      >WIN 79,1,14,24
0A41- 4090      >REP 10,1
0A44- 4100      >WIN 0,80,13,24
0A49- 4110      >FCL
0A4B- 4120      >FIL 23,-
0A4E- 4130      >WIN 0,80,0,24
0A53- 4140      >VTAB 24
0A55- 00 4150      .HS 00      End of message
0A56- 60 4160      RTS
4170 #-----

```

Since we published my patches to allow DOS 3.3 to use the UniDisk 3.5 last May and June I've been using it every day, and just loving all that space. After basking in readers' praise for such a useful piece of code, you can imagine how I felt when I first went to boot that disk on the IIgs and watched it crash into the dirt!

After a little detective work the cause is found: When we boot from the //e Protocol Converter Interface it passes slot\*16 in the A- and X-registers and the slot number in location \$58. In my boot code in FORMAT.UNIDISK I was using the A-register and the contents of \$58 to set up my RWTS. Come to find out, the IIgs only gives us the slot\*16 in the X-register, so we have to do a little more manipulation to create the values we need. Here is the revised code:

```

3080 BOOT    TXA
3082        PHA        save slot*16
3090        LSR        .divide
3092        LSR        ..by 16
3094        LSR        ...to get
3096        LSR        ....slot

```

To update the boot image on an existing disk you can use the instructions at the top of page 23 of the July '86 issue. Be sure to note the caution in the last paragraph of page 21 in that issue, about not installing a DOS image that already contains RAMdisk patches: I tripped over that again myself!

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Digging into the 65816 Apple IIgs has provided more entertainment than I've had since the introduction of the Apple II. So far, my programming efforts have been in the ProDOS 8 environment. When Apple gets its act together on ProDOS 16, writing position-independent code will become critical. Why not do a bit of preparing now? (The following techniques will apply to older Apples which have been upgraded with a 65802 cpu chip, also.)

Absolute internal references are the bugaboo of the position-independent programmer. (By the way, I am not referring to those individuals who program as well standing on their heads as they do flat on their backs or seated in a chair; I am referring to programs which run correctly no matter where they are loaded into memory, without any modifications to reflect the position in memory.) The three most common absolute internal references are:

- (1) the JMP to a program location;
- (2) the JSR to a subroutine location; and
- (3) the reading from or writing to program text or data tables or variables.

The first problem can be solved simply by using the BRL instruction instead of JMP. For avoiding the second and third traps, the PER opcode is an ideal tool. The solutions outlined below pertain only to code and data within one 64K bank of memory. Solutions which handle programs and data in multiple banks will have to wait for future articles.

PER is one of the new opcodes found in the 65802 and 65816. PER stands for "Push Effective program counter (PC) Relative data word onto stack", and employs a hybrid stack/PC-relative addressing mode. PER adds the 16-bit signed displacement in its two-byte operand to the current value for the PC and pushes the result onto the stack. As usual, the high byte is pushed first, then the low byte. Regardless of the values for the m-, x-, and e-status bits, two bytes are always pushed onto the stack. Because the operand is a displacement relative to the PC, the top two bytes of the stack always will point to the designated program code or data, irrespective of whether it is internal or external to the program. Thus, an internal JSR can be simulated by the following sequence:

```
                PER CONTINUE-1
                BRA SUBROUTINE
CONTINUE ...
                ...
                ...
SUBROUTINE ...
                ...
                RTS
```

Note that the continuation address to be placed on the stack must be one less than the desired address (CONTINUE-1 above),

because the RTS opcode increments the address it finds on the stack before jumping to that address. Also note that the BRA opcode works well if the subroutine is nearby (within about + or - 128 bytes of the BRA itself); if the subroutine is further away, you will need to use the BRL opcode here.

I have constructed two macros in the listing of the program which follows. >BSR calls nearby subroutines, and >BSL calls both nearby and distant subroutines. The macro definitions are in lines 1130-1210, and I have shown them in use in lines 1320-1330. The listed program itself is rather trivial, designed just to illustrate my contrived solutions. Lines 1270-1340 clear the screen and then print out the hex values from \$00 to \$F0, with an interval of \$10. The two loops in lines 1350-1560 show two different ways to access data which is part of a program and still be position-independent; their function is to print out a string.

To access internal data, PER again comes to the rescue by allowing us to establish an external (zero page or stack) pointer to the data. Here, the operand must represent the exact address of the target data. The first example stores the pointer generated by PER into a pointer-variable in page zero (lines 1360-1400). PER puts the pointer onto the stack, and two PLAs pull it back off. If we were in Native mode with the m-bit cleared for 16-bit operation, only one PLA and STA would be needed. We could replace lines 1370-1400 with:

```
CLC
XCE          ENTER NATIVE MODE
REP #$20     M=0, 16-BIT DATA
PLA          PULL OFF BOTH BYTES
STA PTR      STORE BOTH BYTES
XCE          BACK TO EMULATION MODE
```

The second approach is to leave the REP-generated pointer on the stack. Line 1500 shows how we can use it with stack-relative indirect-indexed address mode to access the same text string. Lines 1550 and 1560 are then absolutely necessary, to remove the pointer from the stack when we are finished with it.

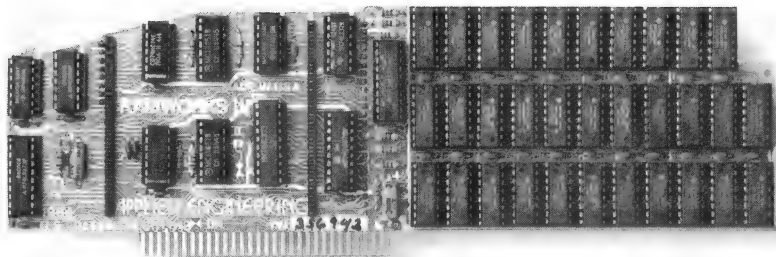
Though it is not appropriate for this sample program, the power of native mode is evident when working with 16-bit address pointers. The problem of using native mode in simple examples is that you cannot call the old standard monitor entry points (such as HOME, COUT, and PRBYTE) from native mode.

If you are going to write code which will be crossing 64K banks, you can still use the PER instruction. However, you also have to take into account the program bank and data bank registers. More on this at another time.

```
1000 #SAVE S.POSITION
1010 #-----
1020 #   POSITION INDEPENDENT CODE WITH THE 65802/16
1030 #-----
      1040 .OP 65816
06-    1050 #-----
      1060 NUM .EQ $06
07-    1070 PTR .EQ $07,08
      1080 #-----
```

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RamWorks III is the newest 3rd generation RAM card for the Apple IIe. It incorporates all of the technology and improvements that years of experience and over a hundred thousand sales have given us. By selling more memory cards than anyone else and listening to our customers, we were able to design a memory card that has the ultimate in performance, quality, compatibility and ease of use. A design so advanced it's patented. We call it RamWorks III, you'll call it awesome!

## **The AppleWorks Amplifier.**

While RamWorks III is recognized by all memory intensive programs, NO other expansion card comes close to offering the multitude of enhancements to AppleWorks that RamWorks III does. Naturally, you'd expect RamWorks III to expand the available desktop, after all Applied Engineering was a year ahead of everyone else *including Apple* in offering more than 55K, and we still provide the largest AppleWorks desktops available. But a larger desktop is just part of the story. Look at all the AppleWorks enhancements that even Apple's own card does not provide and *only* RamWorks III does. With a 256K or larger RamWorks III, *all* of AppleWorks (including printer routines) will automatically load itself into RAM dramatically increasing speed by eliminating the time required to access the program disk drive. Switch from word processing to spreadsheet to database at the speed of light with no wear on disk drives.

*Only* RamWorks eliminates AppleWorks' internal memory limits, increasing the maximum number of records available from 1,350 to over 25,000. *Only* RamWorks increases the number of lines permitted in the word processing mode from 2,250 to over 15,000. And *only* RamWorks offers a built-in printer buffer, so you won't have to wait for your printer to stop before returning to AppleWorks. RamWorks even expands the clipboard. And auto segments large files so they can be saved on two or more disks. You can even have Pinpoint or MacroWorks and your favorite spelling checker in RAM for instant response.

RamWorks, *nothing* comes close to enhancing AppleWorks so much.

## **The Most Friendly, Most Compatible Card Available.**

Using RamWorks III couldn't be easier because it's compatible with more off-the-shelf software than any other RAM card. Popular programs like AppleWorks, Pinpoint, Catalyst, MouseDesk, HowardSoft, FlashCalc, Pro-File, Managing Your Money, SuperCalc 3a, and MagiCalc to name a few (and *all* hardware add on's like Profile and Sider hard disks). RamWorks is even compatible with software written for Apple cards. But unlike other cards, RamWorks plugs into the IIe auxiliary slot providing our super sharp 80 column text (U.S. Patent #4601081) in a completely integrated system while leaving expansion slots 1 through 7 available for other peripheral cards.

RamWorks III is compatible with all

Apple IIe's, enhanced, unenhanced, American or European versions.

## **Highest Memory Expansion.**

Applied Engineering has always offered the largest memory for the IIe and RamWorks III continues that tradition by expanding to 1 full MEG on the main card using standard RAMs, more than most will ever need (1 meg is about 500 pages of text)...but if you do ever need more than 1 MEG, RamWorks III has the widest selection of expander cards available. Additional 512K, 2 MEG, or 16 MEG cards just snap directly onto RamWorks III by plugging into the industry's only low profile (no slot 1 interference) fully decoded memory expansion connector. You can also choose non-volatile, power independent expanders allowing permanent storage for up to 20 years.

## **It Even Corrects Mistakes.**

If you've got some other RAM card that's not being recognized by your programs, and you want RamWorks III, you're in luck. Because all you have to do is plug the memory chips from your current card into the expansion sockets on RamWorks to recapture most of your investment!

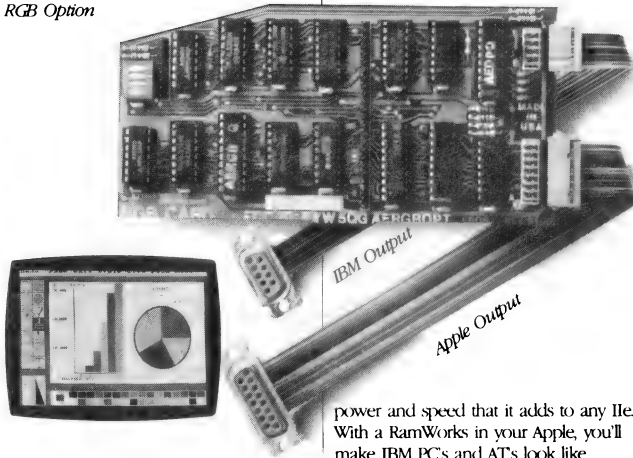
## **The Ultimate in RGB Color.**

RGB color is an option on RamWorks and with good reason. Some others combine RGB color output with their memory cards, but that's unfair for those who don't need RGB *and* for those that do. Because if you don't need RGB



Applied Engineering doesn't make you buy it, but if you want RGB output you're in for a nice surprise because the RamWorks RGB option offers better color graphics plus a more readable 80 column text (that blows away any composite color monitor). For only \$129 it can be added to RamWorks giving you a razor sharp, vivid brilliance that most claim is the best they have ever seen. You'll also appreciate the multiple text colors (others only have green) that come standard. But the RamWorks RGB option is more than just the ultimate in color output because unlike others, it's fully compatible with all the Apple standards for RGB output control, making it more compatible with off-the-shelf software. With its FCC certified design, you can use almost any RGB monitor because only the new RamWorks RGB option provides both Apple standard and IBM standard RGB outputs (cables included). The RGB option plugs into the back of RamWorks with no slot 1 inter-

#### RGB Option



ference and remember you can order the RGB option with your RamWorks or add it on at a later date.

#### True 65C816 16 Bit Power.

RamWorks III has a built-in 65C816 CPU port for direct connection to our optional 65C816 card. The only one capable of linearly addressing more than 1 meg of memory for power applications like running the Lotus 1-2-3™ compatible program, VIP Professional. Our 65C816 card does not use another slot but replaces the 65C02 yet maintains full 8 bit compatibility.

#### Endorsed by the Experts.

A+ magazine said "Applied Engineering's RamWorks is a boon to those who must use large files with AppleWorks...I like the product so much that I am buying one for my own system." inCider magazine said "RamWorks is the most



Steve Wozniak, the creator of Apple Computer

*"I wanted a memory card for my Apple that was fast, easy to use, and very compatible; so I bought RamWorks."*

powerful auxiliary slot memory card available for your IIe, and I rate it four stars..For my money, Applied Engineering's RamWorks is king of the hill."

Apple experts everywhere are impressed by RamWorks's expandability, versatility, ease of use, and the sheer

coverage no matter where you purchase

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- Expandable to 1 MEG on main card
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- Can use 64K or 256K RAMs
- Powerful linear addressing 16 bit coprocessor port
- Automatic AppleWorks expansion up to 3017K desktop
- Accelerates AppleWorks
- Built-in AppleWorks printer buffer
- The only large RAM card that's 100% compatible with all IIe software
- RamDrive™ the ultimate disk emulation software included free
- Memory is easily partitioned allowing many programs in memory at once
- Compatible, RGB option featuring ultra high resolution color graphics and multiple text colors, with cables for both Apple and IBM type monitors
- Built-in self diagnostics software
- Lowest power consumption (U.S. Patent #4601081)
- Takes only one slot (auxiliary) even when fully expanded
- Socketed and user upgradeable
- Software industry standard
- Advanced Computer Aided Design
- Used by Apple Computer, Steve Wozniak and virtually all software companies
- Displays date and time on the AppleWorks screen with any PRO-DOS compatible clock
- Much, much more!

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<b>RamWorks III with 256K</b>	<b>\$219</b>
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power and speed that it adds to any IIe. With a RamWorks in your Apple, you'll make IBM PC's and AT's look like slowpokes.

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```

FC58-      1090 HOME .EQ $FC58
FD58-      1100 PRBYTE .EQ $FD58
FD58-      1110 COUT .EQ $FD58
1120 *-----
1130      .MA BSR      BRANCH RELATIVE TO SUBROUTINE
1140      PER :1+1    When Subroutine is Nearby
1150 :1      BRA J1
1160      .EM
1170 *-----
1180      .MA BSL      BRANCH RELATIVE TO SUBROUTINE
1190      PER :1+2    When Subroutine is Far Away
1200 :1      BRL J1
1210      .EM
1220 *-----
1230 TRIVIAL.EXAMPLE
000800- 38      1240 SEC      SET EMULATION MODE
000801- FB      1250 XCE      IN CASE CALLED FROM NATIVE MODE
000802- 08      1260 PHP      SAVE E-BIT
000803- 20 58 FC 1270 *---Show Position-Independent subroutine calls-----
000806- A9 00      1280 JSR HOME    CLEAR SCREEN
000808- 85 06      1290 LDA #0      FOR NUM = 0 TO $F0 STEP $10
00080A- 20 DA FD 1300 .1      STA NUM
00080D-      1310 JSR PRBYTE    Print in hexadecimal
00080D-      1320 >BSL PRBLNK    Print two blanks
00080D- 62 02 00      0000> PER :1+2    When Subroutine is Far Away
000810- 82 36 01      0000> :1      BRL PRBLNK
000813-      1330 >BSR ADD.10    ...NEXT NUM
000813- 62 01 00      0000> PER :1+1    When Subroutine is Nearby
000816- 80 2B      0000> :1      BRA ADD.10
000818- 90 EE      1340 BCC .1      ...NOT FINISHED YET
00081A- 62 34 01      1350 *---Show Page-Zero Indirect data access-----
00081D- 68      1360 PER TEXT    PUT POINTER TO TEXT ON STACK
00081E- 85 07      1370 PLA      Now put pointer into page zero
000820- 68      1380 STA PTR
000821- 85 08      1390 PLA
000823- A0 00      1400 STA PTR+1
000825- B1 07      1410 LDY #0      Point to beginning of text string
000827- F0 06      1420 .2      LDA (PTR),Y    Get next character of string
000829- 20 ED FD 1430 BEQ .3      End of string
00082C- C8      1440 JSR COUT
00082D- D0 F6      1450 INY
00082D-      1460 BNE .2      ...ALWAYS
00082F- 62 1F 01      1470 *---Show Stack-Indirect data access-----
000832- A0 00      1480 .3      PER TEXT    POINTER TO TEXT ON STACK
000834- B3 01      1490 LDY #0      Point to beginning of text string
000836- F0 06      1500 .4      LDA (1,S),Y    Get next character of string
000838- 20 ED FD 1510 BEQ .5      End of string
00083B- C8      1520 JSR COUT
00083C- D0 F6      1530 INY
00083E- 68      1540 BNE .4      ...ALWAYS
00083F- 68      1550 .5      PLA      POP OFF TEXT POINTER
000840- 28      1560 PLA
000841- FB      1570 *---Return to caller-----
000842- 60      1580 PLP      GET SAVED E-BIT
000842-      1590 XCE      RESTORE E
000842-      1600 RTS
000843- 18      1610 *-----
000844- A5 06      1620 ADD.10 CLC
000846- 69 10      1630 LDA NUM      ADD $10 TO NUM
000848- 60      1640 ADC #$10    SET CARRY IF WRAPS AROUND
000848-      1650 RTS
000849-      1660 *-----
000849-      1670 .BS 256      FILLER TO MOVE PRBLNK FURTHER AWAY
000849-      1680 *-----
000949- A9 A0      1690 PRBLNK LDA #" "
00094B- 20 ED FD 1700 JSR COUT
00094E- 4C ED FD 1710 JMP COUT
000951- 8D      1720 *-----
000952- D0 EF F3 E9 1730 TEXT .HS 8D
000956- F4 E9 EF EE
00095A- AD C9 EE E4
00095E- E5 F0 E5 EE
000962- E4 E5 EE F4
000966- A0 D4 E5 F8
00096A- F4 A0 D3 F4
00096E- F2 E9 EE E7 1740 .AS -/Position-Independent Text String/
000972- 00      1750 .HS 00
000972-      1760 *-----

```

## Simple Line-Input Subroutine.....Bob Sander-Cederlof

The other day I needed a simple subroutine to read a line of text into an assembly language program. The routine had to be short, work in both 40- and 80-columns, and allow very simple editing. It had to read directly from the keyboard, regardless of where the input vector at KSWL (\$38,39) might be pointing.

The following listing shows the result. READ.A.LINE is indeed short and fulfills all the needs I had. Backspace is the only editing character. When you type a printing character, it is displayed and the underline cursor advances. When you type a backspace, the cursor backs up and replaces what was previously at that position.

When you type a RETURN, the routine returns with the X-register pointing into the line buffer at the position where the RETURN is stored. If you type an ESCAPE, it nulls the line you just typed. The line is still in the buffer, but READ.A.LINE returns with the X-register equal to zero.

Inside READ.A.LINE I use the X-register to track position in the line buffer. I don't explicitly keep track of position on the screen, at least in absolute terms. Wherever the cursor is when you call READ.A.LINE is the place where the first cursor will be displayed. Since I do all moving around on the screen by simply printing out characters or backspacing, all screen positions are relative to the beginning position. You can use READ.A.LINE inside a small window if you like, and the input line will wrap nicely when it comes to the edge of the window.

Lines 1100-1120 handle the cursor by first printing an underline, and backspacing over it. Then when you type a character I will put it over the top of the cursor, and come back to line 1100 to display the next cursor.

Lines 1130-1150 are the standard way to read the keyboard when you don't want any firmware interference. (The Apple IIgs has more hardware bells and whistles here, with the Front Desk Processor and all, but this method will still work.)

When you type a backspace, I have to output a space to erase the cursor, then backspace twice and place a new cursor over the top of the character which was right before the old cursor. This is in lines 1350-1380. If the cursor is already at the beginning of the line, lines 1330-1340 will simply start over. Because of the way lines 1330 and 1340 are written, the maximum length line you can type and still use backspace is 128 characters.

I wrote a quick and dirty test program, to illustrate how to use READ.A.LINE. Lines 1500-1560 print out a prompting message. Line 1580 calls READ.A.LINE. The cursor will start right after the prompting message. Line 1600 tests for an ESCAPE, signifying a null entry. If you type RETURN, lines 1610-1670 will display the message you just entered.

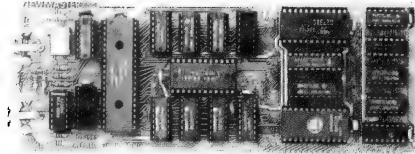
```

1000 *SAVE S.READLINE
1010 *-----
C000- 1020 KEYBOARD .EQ $C000
C010- 1030 STROBE .EQ $C010
1040 *-----
FD8E- 1050 CROUT .EQ $FD8E
FD8E- 1060 COUT .EQ $FDED
1070 *-----
1080 READ.A.LINE
0800- A2 00 1090 .0 LDX #0 Start at beginning of line
0802- A9 DF 1100 .1 LDA # " Use underline for a cursor
0804- 20 ED FD 1110 JSR COUT Print the Underline
0807- 20 49 08 1120 JSR BSOUT ...and back up over it
080A- AD 00 C0 1130 .2 LDA KEYBOARD
080D- 10 FB 1140 BPL .2 ...wait until key pressed
080F- 8D 10 C0 1150 STA STROBE
0812- 9D 4E 08 1160 STA WBUF,X
0815- C9 A0 1170 CMP #A0
0817- 90 0A 1180 BCC .4 CONTROL CHAR
0819- E0 7F 1190 CPX #MAXLEN
081B- B0 ED 1200 BCS .2
081D- 20 ED FD 1210 JSR COUT SHOW IT ON SCREEN
0820- E8 1220 INX
0821- D0 DF 1230 BNE .1 ...ALWAYS
0823- C9 88 1240 .4 CMP #88
0825- F0 0D 1250 BEQ .5 BACKSPACE
0827- C9 9B 1260 CMP #9B
0829- F0 18 1270 BEQ .6 ESCAPE -- ABORT INPUT
082B- C9 8D 1280 CMP #8D
082D- D0 DB 1290 BNE .2 ...NOT <RETURN>, IGNORE IT
082F- 20 46 08 1300 JSR SPCOUT ERASE CURSOR FROM SCREEN
0832- E8 1310 INX INCLUDE <RETURN> IN X-VALUE
0833- 60 1320 RTS RETURN TO CALLER
0834- CA 1330 .5
0835- 30 C9 1340 BMI .0 ...ALREADY AT BEGINNING OF LINE
0837- 20 46 08 1350 JSR SPCOUT ...SPACE
083A- 20 49 08 1360 JSR BSOUT ...BACKSPACE
083D- 20 49 08 1370 JSR BSOUT ...AND ANOTHER
0840- 4C 02 08 1380 JMP .1
0843- A2 00 1390 .6 LDX #0 SIGNAL ESCAPE TYPED
0845- 60 1400 RTS
1410 *-----
0846- A9 A0 1420 SPCOUT LDA # " " SPACE
0848- 2C 1430 .HS 2C
0849- A9 88 1440 BSOUT LDA #88 BACKSPACE
084B- 4C ED FD 1450 JMP COUT
1460 *-----
7F- 1470 MAXLEN .EQ 127
084E- 1480 WBUF .BS MAXLEN+1
1490 *-----
1500 TEST
08CE- A2 00 1510 LDX #0 PRINT OUT A PROMPT MESSAGE
08D0- BD F1 08 1520 .0 LDA PROMPT,X
08D3- 20 ED FD 1530 JSR COUT
08D6- E8 1540 INX
08D7- E0 0F 1550 CPX #PROMPT.LEN
08D9- 90 F5 1560 BCC .0
1570 *-----
08DB- 20 00 08 1580 JSR READ.A.LINE
1590 *-----
08DE- F0 10 1600 BEQ .2 ESCAPE ABORTED IT
08E0- 20 8E FD 1610 JSR CROUT <RETURN> OUTPUT
08E3- A2 00 1620 LDX #0 PRINT OUT THE LINE YOU TYPED IN
08E5- BD 4E 08 1630 .1 LDA WBUF,X
08E8- 20 ED FD 1640 JSR COUT
08EB- E8 1650 INX
08EC- C9 8D 1660 CMP #8D UP TO A <RETURN>
08EE- D0 F5 1670 BNE .1
08F0- 60 1680 .2 RTS
1690 *-----
08F1- C5 EE F4
08F4- E5 F2 A0
08F7- E1 A0 EC
08FA- E9 EE E5
08FD- BA A0 A0 1700 PROMPT .AS -/Enter a line: /
OF- 1710 PROMPT.LEN .EQ #-PROMPT
1720 *-----

```

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## Friendly Decimal Print Subroutine.....Jan Eugenides

Several years ago Bob S-C published a little subroutine to convert two-byte hexadecimal values to decimal and print them. I have written a similar subroutine, but mine allows you to print any character as a leading character when the number has less than five digits, or to have no leading characters at all. Bob's subroutine always printed leading zeroes.

To use my subroutine, you put the number in the A- and X-registers (lo-byte in A, hi-byte in X), and the fill character in the Y-register. If you do not want any fill character, call my subroutine with Y=0. To make calling it easier, Bob S-C constructed a macro named PDEC, defined in lines 1490-1580 below. To print a number with no fill character, simply use the macro like this: >PDEC VALUE; to print with a fill character, use the macro with the fill character as the second parameter like this: >PDEC VALUE,"#".

Now let's look at my subroutine. Lines 1110-1120 store the high byte of the number, and the fill character. I waited to store the low-byte of the number in line 1160, inside the conversion loop, to save a few bytes and cycles.

Lines 1150-1380 comprise a loop controlled by X, counting down from 3 to 0. The loop prints out the first four digits and/or fill characters. X indexes into a power-of-tens table. I first subtract 10000 as many times as possible, counting each subtraction in the Y-register. Since Y starts out as ASCII 0, it increments through successive ASCII digits. When the remainder is finally less than 10000, I print the first digit. Then the process is repeated for 1000, 100, and 10.

Leading-zeroes may be either suppressed, or printed with your choice of fill character. The work is done in lines 1280-1340. I keep a flag in bit 7 of FLAG. This bit starts out 0 (see line 1140). As soon as I get a non-zero digit, I change the flag bit to 1 (see lines 1280-1300). If the flag bit is 1, lines 1310-1320 will decide to print the digit regardless of its value. (We don't want to omit or replace ALL zeroes, only LEADING zeroes.) Lines 1330-1340 will decide whether to print a fill character or nothing at all.

After printing the ten's digit, the remainder in NUM is the units digit in binary. All I have to do is add an ASCII "0" to change this remainder to ASCII, which I do in lines 1390-1400. By handling the unit's digit in this special way I save extra logic which would have been required to make the value \$0000 print at least one zero and two bytes in my power-of-tens table, saving a total of six bytes. The cost is lines 1390 and 1400 versus a simple RTS, or four bytes. This method is also faster, because I don't have to cycle through the loop counting down the unit's digit.

For an exercise, you might try extending my subroutine to convert 3- or 4-byte values. It is really not too difficult. Of course, you would no longer be able to pass the value to be converted in the A- and X-registers. For 3-byte values, the



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power-of-ten tables would have to be extended in both dimensions:

```
TENTBL .DA #10,#100,#1000,#10000
      .DA #100000,#1000000,#10000000
TENTBM .DA /10,/100,/1000,/10000
      .DA /100000,/1000000,/10000000
TENTBH .DA #0,#0,#0,#0
      .DA /100000/256,/1000000/256,/10000000/256
```

You would also have to extend the comparison and subtraction code inside the loop. Why not try it?

```
1000 *SAVE S.PRINT.DECIMAL
1010 *-----
1020 *   By Jan Eugenides and Bob S-C
1030 *
1040 *   Call with A, X, and Y as follows:
1050 *       (A) = low-byte of number to be printed
1060 *       (X) = high byte of number
1070 *       (Y) = fill character (or 00 if no fill)
1080 *-----
FDDED- 1090 COUT .EQ $FDED
1100 *-----
0800- 8E 52 08 1110 PRDEC STY NUM+1   Store high byte of number
0803- 8C 50 08 1120 STY FILL       Store fill character
0806- A2 03      1130 LDX #3        FOR X = 3 TO 0
0808- 8E 4F 08 1140 STY FLAG       Clear bit 7 in leading-zero flag
080B- A0 B0      1150 LDY #0"       Start with digit = ASCII 0
080D- 8D 51 08 1160 .1 STA NUM      Compare number to power of ten
0810- DD 47 08 1170 .2 CMP TENTBL,X 10^(X+1) ... lo-byte
0813- AD 52 08 1180 LDA NUM+1
0816- FD 4B 08 1190 SBC TENTBH,X 10^(X+1) ... hi-byte
0819- 90 0C      1200 BCC .3        Remainder is smaller than 10^(X+1)
081B- 8D 52 08 1210 STA NUM+1   Store remainder hi-byte
081E- AD 51 08 1220 LDA NUM      Get remainder lo-byte
0821- FD 47 08 1230 SBC TENTBL,X
0824- C8      1240 INY          Increment ASCII digit
0825- D0 E6      1250 BNE .2        ...always
1260 *---Print a digit---
0827- 98      1270 .3 TYA          digit in ASCII
0828- C9 B0      1280 CMP #0"       Is it a zero?
082A- F0 03      1290 BEQ .4        ...yes, might be leading zero
082C- 8D 4F 08 1300 STA FLAG       ...no, so clear leading-zero flag
082F- 2C 4F 08 1310 .4 BIT FLAG     If this is leading-zero, will be +
0832- 30 05      1320 BMI .5        ...not a leading zero
0834- AD 50 08 1330 LDA FILL       ...leading zero, so use fill-char
0837- F0 03      1340 BEQ .6        ...Oops, no fill-char
0839- 20 ED FD 1350 .5 JSR COUT      Print the digit or fill-char
083C- AD 51 08 1360 .6 LDA NUM      Get lo-byte of remainder
083F- CA      1370 DEX          Next X
0840- 10 C9      1380 BPL .1        Go get next digit
0842- 09 B0      1390 ORA #0"       Change remainder to ASCII
0844- 4C ED FD 1400 JMP COUT      Print Unit's digit & RTS
1410 *-----
0847- 0A 64 E8 1420 TENTBL .DA #10,#100,#1000,#10000
084A- 10      1430 TENTBH .DA /10,/100,/1000,/10000
084B- 00 00 03 1440 *-----
084E- 27      1450 FLAG .BS 1
1460 FILL .BS 1
0851-      1470 NUM .BS 2
1480 *-----
1490 .ma pdec
1500 lda 1
1510 ldx 1+1
1520 do 1#>1
1530 ldy #12"
1540 .else
1550 ldy #0
1560 .fin
1570 jsr prdec
1580 .em
```

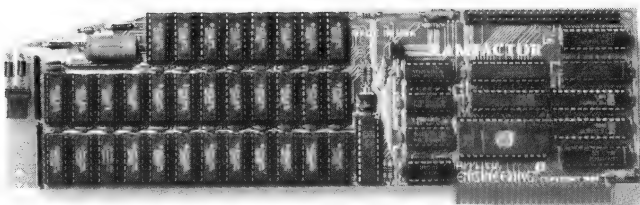


# RamFactor™

*Boot any II+, IIe, or IIGS and be up and running your favorite software in less than 1 second.*

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## Very Compatible

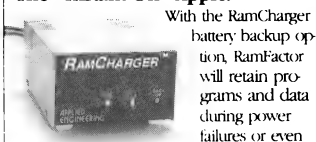
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There are other slot 1-7 cards that give AppleWorks a larger desktop, but that's the end of their story. But RamFactor is the only slot 1-7 card that increases AppleWorks internal memory limits, increasing the maximum number of records in the database and lines permitted in the word processor, and RamFactor is the only standard slot card that will automatically load all of AppleWorks into RAM dramatically increasing speed and eliminating the time required to access the program disk, it will even display the time and date on the AppleWorks screen with any ProDos clock. RamFactor will automatically segment large files so they can be saved on 5¼", 3½", and hard disks. All this performance is available on the Apple II+.

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```

1590 *-----
FD8E-      1600 CROUT .EQ $FD8E
          1610
0853-      1620 T      >PDEC VAL1,#
0853- AD 9A 08 0000>      lda VAL1
0856- AE 9B 08 0000>      ldx VAL1+1
          0000>      .do 2>1
0859- AO A3 0000>      ldy #""
          0000>      .else
          0000>      .fin
085B- 20 00 08 0000>      jsr prdec
085E- 20 8E FD 1630      JSR CROUT
0861-      1640      >PDEC VAL2,^
0861- AD 9C 08 0000>      lda VAL2
0864- AE 9D 08 0000>      ldx VAL2+1
          0000>      .do 2>1
0867- AO DE 0000>      ldy #""
          0000>      .else
          0000>      .fin
0869- 20 00 08 0000>      jsr prdec
086C- 20 8E FD 1650      JSR CROUT
086F-      1660      >PDEC VAL3
086F- AD 9E 08 0000>      lda VAL3
0872- AE 9F 08 0000>      ldx VAL3+1
          0000>      .do 1>1
          0000>      .else
0875- AO 00 0000>      ldy #0
          0000>      .fin
0877- 20 00 08 0000>      jsr prdec
087A- 20 8E FD 1670      JSR CROUT
087D-      1680      >PDEC VAL4
087D- AD A0 08 0000>      lda VAL4
0880- AE A1 08 0000>      ldx VAL4+1
          0000>      .do 1>1
          0000>      .else
0883- AO 00 0000>      ldy #0
          0000>      .fin
0885- 20 00 08 0000>      jsr prdec
0888- 20 8E FD 1690      JSR CROUT
088B-      1700      >PDEC VAL5," "
088B- AD A2 08 0000>      lda VAL5
088E- AE A3 08 0000>      ldx VAL5+1
          0000>      .do 2>1
0891- AO A0 0000>      ldy #""
          0000>      .else
          0000>      .fin
0893- 20 00 08 0000>      jsr prdec
0896- 20 8E FD 1710      JSR CROUT
0899- 60      1720      RTS
          1730
089A- D2 04      1740 VAL1      .DA 1234
089C- 4F 00      1750 VAL2      .DA 79
089E- FF FF      1760 VAL3      .DA 65535
08A0- 4B 1B      1770 VAL4      .DA 6987
08A2- 17 00      1780 VAL5      .DA 23

```

#### Note from American Foundation for the Blind

The American Foundation for the Blind is managing a database of individuals with hands-on experience with computers, low vision aids, talking products, and other devices for the blind and visually-impaired. About 500 users and evaluators are currently listed in their database, and are available to help in training, purchase decisions, and evaluation of new products. If you have related experience are interested in helping, or could use such help yourself, you can contact their National Technology Center at 1-800-232-5463.

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*Steve Wozniak, the creator  
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Some time ago Bruce Love, a mathematics teacher at Hillcrest High School in New Zealand, sent me a macro he has found quite handy. It is shown in lines 1010-1090 in the listing below. It can be used to generate in-line loops to copy a group of bytes from one place to another. The macro works with any group up to 256 bytes long. It is really quite flexible, as the several examples in lines 1460-1550 reveal. Note that the source and destination may be either absolute or indirect in form. Furthermore, the length may either be stored in a variable or in the immediate form.

I added the SET macro (lines 1170-1230) to set up a pointer, to simplify using the MOVE macro with pointers in page zero. An example of its use is in lines 1490 and 1500.

There is another macro that I have found useful for moving larger chunks of RAM around. I use it especially in ProDOS SYSTEM files for relocating program sections. See lines 1100-1160 for the definition of the COPY macro, which moves up to 256 pages from source to destination. The parameters for COPY are reminiscent of the monitor M-command. For example, to copy \$4B00 through \$5FFF to a destination beginning at \$6A00 the monitor command would be "6A00<4B00.5FFFM". The equivalent COPY macro would be "COPY \$6A00,\$4B00,\$5FFF".

With both of these macros, beware of overlapping the range of the source and destination just as you would with the monitor M-command. Unless, of course, you know what you are doing and are doing it on purpose. For example, you can copy the first character of a block to all positions in the block like this:

```
>MOVE BUFFER,BUFFER+1,LEN
```

As is usually the case with macros which generate code, the code will probably not be as efficient as you could write given more knowledge of the overall situation. However, macros like these can shorten the time to develop programs, and thus they are worthy in spite of their possible inefficiencies.

```

1000 *SAVE MOVE.MACROS
1010 *-----
1020      .MA MOVE source,destination,length
1030      LDY #0
1040 :1    LDA [1,Y      GET SOURCE BYTE
1050      STA [2,Y      STORE DEST. BYTE
1060      INY           NEXT BYTE
1070      CPY [3
1080      BCC :1        ...IF MORE
1090      .EM
1100 *-----
1110      .MA COPY destination,src.start,src.end
1120      LDA [1        DESTINATION PAGE
1130      LDY [2        SOURCE BEGINNING PAGE
1140      LDX [3-[2+256  # OF PAGES
1150      JSR COPY.PAGES
1160      .EM
1170 *-----
1180      .MA SET pointer,value
1190      LDA [12
1200      STA [1
1210      LDA [2
1220      STA [1+1
1230      .EM

```

```

1240 *-----
00- 1250 SPTR .EQ $00,01
02- 1260 DPTR .EQ $02,03
04- 1270 LENGTH .EQ $04
0200- 1280 BUFFER .EQ $200
1290 *-----
1300 COPY.PAGES
0800- 85 03 1310 STA DPTR+1
0802- 84 01 1320 STY SPTR+1
0804- A0 00 1330 LDY #0
0806- 84 02 1340 STY DPTR
0808- 84 00 1350 STY SPTR
080A- B1 00 1360 .1 LDA (SPTR),Y
080C- 91 02 1370 STA (DPTR),Y
080E- C8 1380 INY NEXT BYTE
080F- D0 F9 1390 BNE .1 ...KEEP GOING
0811- E6 01 1400 INC SPTR+1 ...END OF PAGE
0813- E6 03 1410 INC DPTR+1
0815- CA 1420 DEX NEXT PAGE
0816- D0 F2 1430 BNE .1 ...KEEP GOING
0818- 60 1440 RTS ...FINISHED
1450 *-----
1460 SAMPLE.MOVES
0819- A0 00 1470 >MOVE $500,$600,#40
081B- B9 00 05 0000> LDY #0
081E- 99 00 06 0000> :1 LDA $500,Y GET SOURCE BYTE
0821- C8 0000> STA $600,Y STORE DEST. BYTE
0822- C0 28 0000> INY NEXT BYTE
0824- 90 F5 0000> CPY #40
0000> BCC :1 ...IF MORE
1480 *-----
0826- 1490 >SET SPTR,BUFFER+10
0826- A9 0A 0000> LDA #BUFFER+10
0828- 85 00 0000> STA SPTR
082A- A9 02 0000> LDA /BUFFER+10
082C- 85 01 0000> STA SPTR+1
082E- 1500 >SET DPTR,BUFFER+40
082E- A9 28 0000> LDA #BUFFER+40
0830- 85 02 0000> STA DPTR
0832- A9 02 0000> LDA /BUFFER+40
0834- 85 03 0000> STA DPTR+1
0836- A9 09 1510 LDA #9
0838- 85 04 1520 STA LENGTH
083A- 1530 >MOVE (SPTR),(DPTR),LENGTH
083A- A0 00 0000> LDY #0
083C- B1 00 0000> :1 LDA (SPTR),Y GET SOURCE BYTE
083E- 91 02 0000> STA (DPTR),Y STORE DEST. BYTE
0840- C8 0000> INY NEXT BYTE
0841- C4 04 0000> CPY LENGTH
0843- 90 F7 0000> BCC :1 ...IF MORE
1540 *-----
0845- 1550 >MOVE BUFFER,(DPTR),#10
0845- A0 00 0000> LDY #0
0847- B9 00 02 0000> :1 LDA BUFFER,Y GET SOURCE BYTE
084A- 91 02 0000> STA (DPTR),Y STORE DEST. BYTE
084C- C8 0000> INY NEXT BYTE
084D- C0 0A 0000> CPY #10
084F- 90 F6 0000> BCC :1 ...IF MORE
1560 *-----
1570 SAMPLE.COPIES
0851- 1580 >COPY $6A00,$4B00,$5FFF
0851- A9 6A 0000> LDA /$6A00 DESTINATION PAGE
0853- A0 4B 0000> LDY /$4B00 SOURCE BEGINNING PAGE
0855- A2 15 0000> LDX /$5FFF-$4B00+256 # OF PAGES
0857- 20 00 08 0000> JSR COPY.PAGES
085A- 1590 >COPY $5000,$2200,$4AFF
085A- A9 50 0000> LDA /$5000 DESTINATION PAGE
085C- A0 22 0000> LDY /$2200 SOURCE BEGINNING PAGE
085E- A2 29 0000> LDX /$4AFF-$2200+256 # OF PAGES
0860- 20 00 08 0000> JSR COPY.PAGES
0863- 1600 >COPY $1000,BUFFER,BUFFER+255
0863- A9 10 0000> LDA /$1000 DESTINATION PAGE
0865- A0 02 0000> LDY /BUFFER SOURCE BEGINNING PAGE
0867- A2 01 0000> LDX /BUFFER+255-BUFFER+256 # OF PAGES
0869- 20 00 08 0000> JSR COPY.PAGES
086C- 60 1610 RTS
1620 *-----

```

## New Supplement to "Beneath Apple ProDOS" Available

Quality Software has published a new supplement to for "Beneath Apple ProDOS," which includes information on ProDOS versions 1.2 and 1.3. It is 30 pages longer than the previous edition, which covered version 1.1.1 of ProDOS.

You might be wondering, "What is a supplement, anyway?" The book "Beneath Apple ProDOS" ("BAP") contains much reference material needed to really take advantage of ProDOS capabilities. While other books now cover much of the same ground, "BAP" was the first one to put it all into print. The supplement, however, is unique: it contains a complete description of the internal details of both the ProDOS MLI kernel and BASIC.SYSTEM. If you are at all involved with the inner works of ProDOS, or are having trouble finding out the REAL scoop on some issues, you NEED the supplement. I have used my copies extensively, and depended heavily on it when writing the ProDOS version of S-C Macro Assembler.

The original supplement, for versions 1.0.1 and 1.0.2 cost \$10. The second and third editions are \$12.50 each. Incredibly low-priced! You must order these directly from Quality Software, at 21610 Lassen Street #7, Chatsworth, CA 91311. As I understand it, the supplement is only sold to owners of "BAP", and you have to use the coupon found on page 8-9 of "BAP" to do the ordering. ("BAP" itself is \$19.95 retail, but we sell it for \$18 here.)

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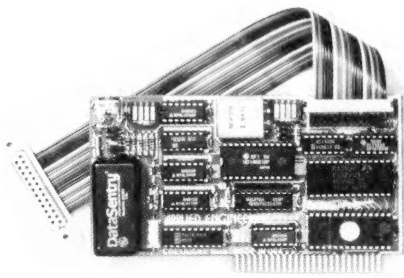
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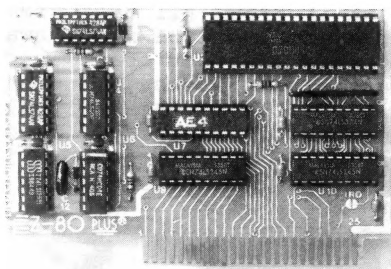
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Gina Montagano, of the Software Toolworks, recently sent me "Chessmaster 2000". If you have not heard of it, Chessmaster is a really good chess-playing program which will run on the Apple II family. It is also available for Mac, IBM, and others. I bought Microchess back in 1977, and Sargon in 1978; they did well, considering they ran in such small machines. Microchess would fit in a 4K Apple! We have come a long way since then. Chessmaster has many nice features, is the current reigning "champion", and is well worth the \$49.95 price. (My 11-year-old stepson Matthew figured out a neat way to beat it. He let it tromp all over him, all the way to checkmate. Then he stepped back one move, swapped sides, and won!) Some features: display board in color or monochrome, 2-D or 3-D; 20 levels of competence, plus one that purposely makes occasional obviously bad moves; optional hints for your best move; huge opening book; library of famous games; and on and on. Negative: copy protected, although you may order a backup copy for \$5. Chessmaster 2000 is available at most software stores.

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